INFLUENCE OF NATURAL AND ANTHROPOGENIC FACTORS ON THE EFFECTS OF CLIMATE CHANGE INDUCED FLOODING IN LOKOJA URBAN CENTRE

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Abstract - The incidences of flooding are increasing in different parts of the world owing to climate change while natural and anthropogenic factors are exacerbating the damaging effects of these floods. This study aimed to identify the influence of these factors on the effects of climate change induced flooding in Lokoja urban centre with the objective of ascertaining the exacerbation of the vulnerability of Lokoja urban centre to the effects of flooding occasioned by climate change through these factors. Primary data for the study were sourced through 800 copies of questionnaire administered in the survey research. Data analysis was performed and the hypothesis was tested with the stepwise regression analysis. Findings revealed that there are natural and anthropogenic factors that exacerbate the vulnerability of Lokoja to the effects of climate change. The natural factor is distance of house from edge of Meme/Niger River which had p-value of 0.033 and the anthropogenic factors are improper land use pattern and condition/design of drains with 0.000 and 0.032 p-values respectively. It is suggested that; further building development along the banks of the Niger and Meme rivers should be prohibited for the avoidance of loss of life and property, the state Urban Planning and Development Board should promote and enforce appropriate land use by building developers in the study area and additional surface drainage channels should be provided while the channels that are already silted and blocked should be cleaned to allow for controlled free flow of rainwater across the study area.

Keywords - Climate Change, Natural Factors, Anthropogenic Factors, Flooding.

I. INTRODUCTION

All over the world, households, industries and infrastructure, intense economic activities and large sizes of the built environment in urban centres contribute greatly to the emission of greenhouse gases thereby increasing the risk of floods, occasioned by heat bearing on glaciers in the northern hemisphere (Enete, and Ayadiulo, 2012). Hence, urban areas and urban infrastructure on account of aforementioned contribute significantly to the displacement of natural and agricultural landscapes leading to extreme reconfiguration of vegetation, even to the point of its total loss. (Werner and Zahner, 2009).

Floods, which are occasioned by the overflowing of water unto land that is normally dry, come in the 2 broad types of; river flood and coastal flood. River floods can be flash floods which are caused by convection storms or long rain floods which are caused by prolonged low intensity rainfall, while Coastal floods can be caused by meteorological disturbances, seismic disturbances or lakeshore floods. Other forms of flooding are, surface water flooding, groundwater flooding, Drain and sewer flooding, broken water mains flooding and broken dams flooding. All these types of flood put together cause 40 percent of the world's natural disasters and account for more than half of the fatalities (Ologunorisa, 2006; Scottish Environmental Protection Agency, 2012; National Geographic, 2013). This makes flood management a very crucial component of natural disaster management which requires concerted attention and cooperation of stakeholders like governments, affected population, insurance industry, scientists, environmentalists, architects and engineers with a view to generating unambiguous policy options, and promotion of the campaign for the reduction of climate change (Berz, 2000).

II. AIM AND OBJECTIVE

The aim of this work is to ascertain the influence of natural and anthropogenic factors on the effects of climate change induced flooding in Lokoja urban centre and the objective is to identify the natural and manmade factors that exacerbate the vulnerability of Lokoja urban centre to the effects of flooding occasioned by climate change.

III. HYPOTHESIS

The following hypothesis was formulated; H_o: the degree of vulnerability of Lokoja town to the effects of flooding occasioned by climate change is not significantly exacerbated by natural and anthropogenic factors.

IV. REVIEW OF RELEVANT LITERATURE

Extrinsic natural factors such as coastal flooding, tornadoes, hurricanes, cyclones and tsunamis contribute in no small measure to predisposition to vulnerability. Settlement location plays a key role in vulnerability accounts; clear examples of this are the

low income residential axes of urban areas which continue to predispose their inhabitants to disaster risks owing to erection of dwelling units in harmful quarters such as areas likely to experience flooding, earthquake, landslides, etc (UNEP, 2007). Nations and communities differ in environmental situations and capacity, for instance, some countries are disadvantageously located in disaster prone areas like the tsunami, cyclone and hurricane belts of Southern Asia, Pacific Islands and Central America respectively. Very good examples are the 52 Small Island Developing States (SIDS), among which are Anguilla, American Samoa and Cape Verde, that are located in remote and low lying coastal parts of the world with minute land space mostly scattered in archipelagos that are facing among other challenges, propensity to natural disasters, vulnerability to external shocks, poverty and environmental degradation (UNESCAP, 2000; Abramovitz, et al 2002; Kumpulainen 2006).

Aside from coastal areas, settlements along river banks also experience vulnerabilities owing to their location. Examples of such settlements are Khartoum, Aswan, Luxor along the Nile River in Sudan and Egypt, Mopti, Kainji, Lokoja and Onitsha along the Niger in Mali and Nigeria. Also, vulnerability of the population around here to the floods occasioned in the Nile Basin is partly due to the edaphic and topographic characteristic of the area (Zakieldeen, 2008; UNEP, 2010). Situated on the Niger River in Nigeria are two of the nation's biggest hydroelectric dams – the Kainji and Jebba dams – which alongside the Shiroro dam (located on the Kaduna River) have a combined active capacity of 18.6×10^9 m^3. These dams affect their down streams in any one of two ways, depending on the prevailing situation. The first is when there is inadequate rainfall and water is not released to the downstream causing ecological and environmental problems and the second is when there is excessive rainfall and the dams are opened, discharging too much water into the downstream thereby causing severe flooding with the attendant economic, social and other problems for communities along down streams (Salami and Sule, 2010).

The case at Lokoja is compounded owing to by its location at the confluence of Nigeria's two great rivers, the Niger and Benue. The Niger has the two aforementioned dams and the Benue has the Lagdo dam in Cameroun. With effect from 1991, perennial flooding had become almost synonymous with Lokoja and in 2012 it was really grave, as owing to excessive rainfall and consequent discharge of water from the dams on the two great rivers severe flooding of catastrophic nature affected Lokoja and others towns along the courses of the two great rivers. (Audu, 2012; Suleiman, Matazu, Davids, and Mozie, 2014).

Emerging trends in urban designs to address the flooding challenge of climate change include watertighting, flood shielding, floating construction, amphibious construction, elevated construction, dry-wet proof construction and construction on piles (van der Pol, 2012). The Makoko Floating School, MFS, in Makoko, Lagos-Nigeria, designed by a Nigerian architect and built with materials sourced largely from the immediate vicinity of the site is a good example of the floating construction.

The use of porous surfacing for pavements and roads is also getting widespread acceptance over traditional impervious materials. Porous surfacing materials include; porous asphalt, pervious concrete, porous turf, open jointed blocks and interlocking tiles (Matthews, 2011). These surfaces tend to prevent the accumulation of runoff water during flood episodes, thereby reducing the devastating effects of flooding.

V. METHODOLOGY

The survey research method was applied to gather primary data for this study while desk research was employed to gather secondary data with relevant data sourced from Nigerian Meteorological Agency (NIMET) and the National Population Commission (NPC). A sample size of the target population was used for the survey and the results and findings were then generalized for the target population. The projected population of Lokoja for 2014 is 108,826 and for the purpose of this study Lokoja town was divided into 17 zones. The national average household size in Nigeria is 6 hence, the target population for this study would be the 2014 projected population of 108,826 divided by the average household size of 6 which is 18,138 Applying the Taro Yamane formula (Yamane, 1967) for determining sample sizes with error limit of 0.035, the sample size of 781 was arrived at and it was rounded off to 800.

The 17 zones were classified into high, medium and low density areas and the 800 copies of the questionnaire were then administered in ratio 3:2:1, that is, 3 for high density, 2 for medium density and 1 for low density giving 400, 267 and 133 respectively. In the high density area, owing to the geographical sizes of the zones, the copies of the questionnaire were distributed as follows; Kabawa/Kporoka - 55, Felele - 55, Karaworo - 65, Kpata/Marine Road Area - 50, Barracks - 65, Zangon-Daji - 50, Ganaja Village – 60. For the medium density areas owing to the geographical sizes of the zones, the copies of the questionnaire were distributed as follows; Post OfficeArea/New Layout - 25, Gadumo/Old Poly Quarters - 25, Adankolo/Adankolo New Layout - 42, Ganaja Junction Area - 25, Lokongoma Phase I - 25, Lokongoma Phase II - 25, Assembly Quarters/Workers Village/Otokiti Estate - 50, Nataco/Kogi Poly – 40. And for the medium density areas owing to the geographical sizes of the zones, the copies of the questionnaire were distributed as follows; GRA – 73 and Commissioners' Quarters – 60. Copies of the questionnaire were randomly

administered in the various subzones. Out of the 800 copies of questionnaire administered, 779 amounting to 97% of the total were returned. Details are as follows; high density areas - 400, medium density areas -259 and low density areas – 120.

VI. PRESENTATION OF RESULTS

6.1 Ground Surface Condition in Residential Compounds

The study revealed that for high density area, completely built up was 3.3%, bare ground was 37.9%, covered completely with concrete was 8.4%, paving/concrete was 3.9% and grassing/flowering plants/paving was 2.0%. The medium density area had; completely built up as 3.4%, bare ground as 20.2%, covered completely with concrete as 5.2%, paving/concrete was 3.7% and grassing/flowering plants/paving as 4.3%. Furthermore, the low density area had; completely built up as 0%, bare ground as 3.1%, covered completely with concrete as 3.1%, paving/concrete was 0.9% and grassing/flowering plants/paving as 0.6%. The restriction of the completely built up area to only the high and medium density areas reflects the position that residents in this areas have the tendency to unduly maximize the use of land.

At the general level, assessing ground surface condition in the study revealed that, completely built up had 6.7%, bare ground had the highest percentage of 61.2, while covered completely with concrete and paving/concrete jointly had 25.2% and grassing/flowering plants/paving had a mere 6.9%. This reflects the possibility of a significant degree of urban heat island effect owing to anthropogenic factors.

6.2 Housing Type

The survey, revealed that the single unit housing type had the highest overall percentage of 24.5% spread between the high and medium density areas as 16.1% and 8.4% respectively. The block of flats, bungalow and storey, jointly had 31.4% spread across the high, medium and low density areas as 16.4%, 12.1% and 2.9% respectively while single family dwelling unit, bungalow and storey, jointly had 44.1% spread across the high, medium and low density areas as 23%, 16.3% and 4.8%. While the single room apartments are located in the high and medium density areas, the other building types were found in all the density areas. Another situation observed in the responses was that all the building types had significant representation in the high and medium income areas.

6.3 Topography of Dwelling Area

The study considered mountain top, flood plain, steep slope, gentle slope and flat terrain under topography of dwelling area. In all, 14.8% of respondent had their dwelling places on mountain top, 8.5% had theirs on flood plains, 11.1% had theirs on steep slope, 29.2% had theirs on gentle slope and 36.4% had theirs on flat terrain. With cumulative percentages of flood plain, steep slope and gentle slope standing at 48.8, it can be posited that about half of the town is vulnerable in one way or another to the effects of flooding in the form of flash flood or long rain flood as buildings standing in the way of flood water in the absence of proper drainage can easily be affected.

According to responses in the survey, the 8.5% of buildings in the flood plain are located in the high and medium density areas largely occupied by low and medium income earners a situation which heightens vulnerability. While the buildings on the mountain top may not be vulnerable to flooding, accessing them in flood situation may not be easy either, especially if the roads leading to them are caught up in the flood. Again the buildings on the mountain top are located in the high and medium income areas accounting for 7.8% and 7.0% respectively.

6.4 Condition of Access Road/Adjacent Road

The earth roads without drains accounted for 48.8% of the roads in the study area, closely behind that were tarred roads with drains – 27.4%, next was tarred roads without drains – 15.1%, while tagging along were paved roads with drains – 6.1% and paved roads without drains – 2.6%. 66.5% of roads in the study area were discovered to be without drains a situation that easily predisposes to flooding when rain water flows without properly defined channels in the form of gutters and canals. High density areas had the highest percentage of roads without drains (39.3%) and it is necessary that this be addressed to reduce vulnerability to flooding; however this density area also has the highest percentage of roads with drains (16.2%) in the study (see Table 3).

6.5 Condition/Design of Drains

No drain accounts for 46.7%, earth drains account for 2.7%, concrete narrow rectangular drains account for 25.1%, concrete wide rectangular drains account for 10.3% while concrete trapezoid drains accounts for 15.2%. Of the 46.7% of no drain, 30.9% were from the high density area and 15.8% were from the medium density area. The total of 7.7% recorded in the low density area presents a spread of 7.0% for concrete narrow rectangular drains, 0.4% for concrete with trapezoidal drain and 0.3% for the earth drain indicating that over 90% of roads in the low density areas had drainage.

6.6 Distance of House from Edge of Meme/Niger River

In drawing responses for distance of house from the edge of Meme/Niger River, categories of distance that were considered and their percentages were; less than 21m – 10.0%, 21 to 50m – 6.2%, 51 to 100m – 9.0%, 101 to 200m – 10.2% and above 200m – 64.6%. The 16.2% which were 50m and below away from the rivers were located in the high and medium

income areas. Of the 9.0% located between 51 and 100m only 0.3% fall within the low density area which predominantly (7.4% out of 7.7%) fall within the above 200m bracket.

This means that the high and medium density areas were the ones really disadvantaged in terms of proximity to rivers. Unfortunately, residents of these areas may not be able to easily afford appropriate personal or communal adaptation measures required to combat the effects of the flooding aspect of climate change challenge in Lokoja urban centre.

6.7 Distance of House from Patti Ridge

The Patti ridge is one of the dominant natural features in Lokoja spanning from Zone 8 area through Felele and Sarkin Noma areas up to Banda on the fringes of the 16km radius. The study revealed that 64.2% of the buildings covered by the survey were above 200m away from the Patti ridge while, 11.5% were located within 50m of the Patti ridge. The remaining 24.3% were largely spread between 51m and 199m. Although high and medium income areas comprised of 33.4% and 23.1% respectively of the 64.2% recorded for above 200m, appearing to be higher than the 7.7% recorded by the low income areas, it is necessary to note that the 7.7% is actually 100% of the total number of house covered in the low income areas.

6.8 Improper Land Use Pattern, Inability to trap and Use Running Water from Patti Ridge during Rainfall have all Aggravated Flooding Damage

Responses here were based on the five point Likert scale of strongly disagree, disagree, undecided, agree and strongly agree. The study showed that those who strongly agreed and agreed accounted for 84.1% while the remainder jointly accounted for 15.9% of the responses. Noteworthy is the indication that the responses from the high and medium areas totalled 61.6% out of the 84.1% recorded for strongly agree and agree. This is above 50% of responses in those density areas which is not in consonance with preponderance of land use abuses in there. This suggested that lack of knowledge may not be the reason for the flagrant abuse of land use resulting in the aggravation of damage due to flooding experienced in these areas.

6.9 Lack of Flood Water Reservoirs, Levees along the Bank of River Niger and Protection Measures for the Flood Plains of River Niger have all combined to Aggravate Flooding in Lokoja

79.8% of respondents agreed and strongly agreed that lack of flood water reservoirs, Levees along the Banks of river Niger and protection measures for flood plains of river Niger have all combined to aggravate flooding in Lokoja, with only 21.2% of the respondents being either undecided or not agreeing. A high percentage (58.7%) of respondents in agreement reside in high and medium density areas, this is probably because they were mostly vulnerable to cases of flooding. The high percentage of positively disposed respondents suggests that there may be need to provide these measures to drastically reduce vulnerability.

6.10 How high was the Water on Your Wall during the Last Flood?

35.6% of the respondents experienced water rising from 1.1m to above 3.0m on their walls during the 2012 flood. This is alarming because the 1.75 metres is the average height of a normal human being (Nuefert, 1975), and flood water rising above that is definitely a life threatening challenge that must be taken head long to avert unnecessary loss of lives and property, some of which may not be recoverable. The 62.6% recorded by less than 0.6m to 1.0m is also cause for concern as though not life threatening, may lead to significant loss of property.

VII. TEST OF HYPOTHESIS

H_o: The degree of vulnerability of Lokoja town to the effects of flooding occasioned by climate change is not significantly exacerbated by natural and anthropogenic factors.

Attention was focused on discovering whether natural and manmade factors aggravate the effects of flooding upon the study area. To this end, the hypothesis was tested using the Stepwise Regression Analysis and the result indicated the various values of significance between flooding and the independent variables.

Applying confidence level of 0.05, means that probability value, P-value, less than 0.05 indicates significant relationship while P-value greater than 0.05 indicates no significant relationship. Table 10 further revealed that improper land use pattern, distance of house from edge of Meme/Niger River and condition/design of drains had unstandardized coefficient values of b as -0.614, -0.295 and -0.437, standardized coefficient values of b as -0.203, 0.149 and -0.142 together with significantly related to the dependent variable in the following respective order; 0.000, 0.033 and 0.032.

Table 1 presents the model summary indicating that model 3 accounts for 0.329 R square meaning that the model accounts for 33% of the total variables. The predictors in the analysis comprised of both anthropogenic and natural factors, hence the null hypothesis is rejected and the alternative hypothesis H_1 which is; the degree of vulnerability of Lokoja town to the effects of flooding occasioned by climate change is significantly exacerbated by natural and anthropogenic factors, was accepted.

VIII. DISCUSSION

Natural and anthropogenic factors were shown to aggravate the effects of flooding occasioned by

climate change in the study. As discovered in the study, the natural factor was location, that is, distance of house from the Niger and Meme Rivers, while the manmade factors were; improper land use pattern, inability to trap and use running water from Patti ridge during rainfall and conditions and design of drains. As revealed in the study, 24.5% of the respondents were resident in buildings 100 metres and below from the edge of the Niger and Meme Rivers, while this is just a quarter of the sample population it is worthy of note that these areas are largely in the high and medium density areas of the Lokoja urban centre, the areas that were more vulnerable to the effects of flooding. This is in agreement with Jimoh 2008 which revealed that 78% of respondents who live in the river catchments experienced recurrent inundation of flooding with the resultant effects of loss of property and life. In consonance with this reality, the work carried out by Mulugeta, Ayonghe, Daby, Dube, Lucio and Durrhiem (2007) revealed that floods occasion disasters in Mozambique, Ethiopia, Somalia and Kenya with devastating consequences in the catchment areas of especially the Shabelle and Juba Rivers which overflowed their banks affecting many settlements. Fatile and Adejobi (2012) also asserted that, climate though the instrument of flood had the capacity of impacting very badly on Nigeria with the possibility of affecting the built environment, the agricultural sector, the health sector and the ecosystems.

84% of the respondents in this work agreed that improper land use pattern, inability to trap and use running water from Patti ridge during rainfall have all aggravated flooding damage in the study area. This appeared to have been suggested by Usman and Tunde (2011) together with Ogbo and Onyedinma (2012) in maintaining that the activities of local urban planning bodies in Nigeria had largely been limited to physical layout of cities to the detriment of environmental concerns hence, urban planners need to look in the direction of disaster resistant planning that would increase resilience and reduce vulnerability to natural disasters even as climate change is resulting in increased predictable flooding caused by rainfall variability. Omole and Akinbamijo (2012) with this understanding asserted that the enforcement of planning laws to enshrine appropriate land use pattern is government responsibility and it is important for government to live up to its responsibility.

IPCC 2007 posited that by 2050, there would be likelihood of differentiated behaviour concerning runoff and availability of water together with increased frequency of flood occurrences and attendant severity, while, Enete, Ogbonna and Ayadiulo (2012) opined that local conditions and urban design can increase the effects of climate change. Supporting this is the suggestion of Adedeji and Ogunsote (2011) that development dynamics can sometimes be city specific occasioning poor ventilation, unplanned and difficult to manage cities in Nigeria. Alabi (2009) also suggested that Lokoja is increasing in size in various directions without due regard for land use patterns and this is resulting in environmental losses. These lend credence to the belief that if runoff water from the Patti ridge is not contained and controlled appropriately over time the consequences may be grave, hence serious urban planning measures would be required to prevent this in consonance with the position of Ogbonna and Allu (2011), that the vulnerability of settlements could be reduced through appropriate land use planning. According to OECD (2010), urban centres are more vulnerable to the effects of climate change than rural areas owing to certain attributes like, heavy reliance on the intricate urban infrastructure of transportation, communication, high building density, etc.

Tracing urban planning regulation in Nigeria from the outdated and ineffective old Town and Country Planning Law of 1946 to the Nigerian Urban and Regional Planning Law, (NURPL) Decree No. 88 of December 15, 1992, Omole and Akinbamijo (2012) emphasized that the control of inappropriate indulgences of land developers on the use of land and the environment is the responsibility of government for which enforcement is of utmost importance if success is to be consistently recorded.

Drainage Services Department (2013) and US Department of Transportation (2013) concurred with the position that flooding is not caused by natural factors alone but also by anthropogenic factors with cases such as land use induced runoff, depletion of space for flood storage silting and outright blockade of natural drainage channels with urban and agricultural waste, etc. There is therefore need for the provision and maintenance of comprehensive storm and runoff drainage system of canals, gutters, culverts and river training in urban centres to collect, convey, and discharge storm water flowing within and along the highway right-of-way by way of flood mitigation measures. Drainage systems can either surface, subsurface or a combination of both. With 46.7% (as shown in Table 4) which represent almost half of the respondents not having drainages, it can be seen that there is a serious need for the design and construction of a drainage system in the study area while the existing ones that have been blocked should be properly maintained. There were other independent variables which were considered in the study but they did not have significant relationship with the dependent variable flooding and were excluded. They were; Ground surface condition in residential compounds, Housing type, Topography of dwelling areas, Condition of access road/adjacent road, Distance of house from Patti ridge, Lack of flood water reservoirs and height of water on building wall during the last flood. Topography of dwelling area and distance from Patti ridge were natural while the remaining five were anthropogenic.

IX. CONCLUSION AND RECOMMENDATION

This study investigated influence of natural and anthropogenic factors on the effects of climate change induced flooding in lokoja urban centre. Effort was made to ascertain natural and manmade factors that aggravate the vulnerability of Lokoja to the effects of flooding occasioned by climate change. Several natural and anthropogenic factors considered to be capable of exacerbating effects of climate change in the study area were considered and, it was discovered that distance of house from edge of Meme/Niger River is the natural factor that exacerbate the flooding component of the effects of climate change in the town, while, the anthropogenic factors responsible for this exacerbation are improper land use pattern and condition/design of drains.

To effectively engage the influence of natural and anthropogenic factors on the effects of climate change induced flooding in Lokoja urban centre, the following recommendations are put forward;

1. Prohibition of new building development along the river banks; further building development along the banks of the Niger and Meme rivers should be prohibited for the avoidance of avoidable loss of life and property.
2. The State Government should as a matter of urgency facilitate the completion of the Lokoja master plan project and the state Urban Planning and Development Board should promote and enforce appropriate land use by building developers in the study area.
3. Construction and retrofitting of drainage systems; additional surface drainage channels in the form of canals and road side gutters should be provided and drainage channels that are already silted and blocked should be cleaned to allow for controlled free flow of rainwater across the study area to facilitate the speedy directional discharge of runoff and storm water during periods of intense rainfall and flooding.

REFERENCES

[1] Abramovitz, J., Banuri, T., Girot, P. O., Hammill, A., Orlando, B., Schneider, N., Spanger-Siegfried, E., & Switzer, J. (2002): Adapting to Climate Change: Natural Resource Management and Vulnerability Reduction. Background Paper to the Task Force on Climate Change, Adaptation and Vulnerable Communities. This document is a joint effort of World Conservation Union (IUCN), Worldwatch Institute, International Institute for Sustainable Development (IISD) and Stockholm Environment Institute /Boston (SEI-B)

[2] Adedeji, Y. M. D. and Ogunsote, O. O. (2011): Anticipated contributions of modern building

[3] materials to sustainability: climate change scenarios in hot and humid regions of Nigeria. In Ogusote et al (ed) Compilation of seminar papers of the Architect's Colloquium 2011: 328 – 339.

[4] Alabi, M. O. (2009): Urban Sprawl, Pattern and Measurement in Lokoja, Nigeria. Theoretical and Empirical Researches in Urban Management. 4(13):158 – 164.

[5] Audu, E.B. (2012): A Descriptive Analysis of Rainfall for Agricultural Planning in Lokoja Local Government Area of Kogi State, Nigeria. International Journal of Science and Technology. 2(12):850 – 855

[6] Berz, G. (2000): Flood Disasters: Lessons From the Past – Worries for the Future. Proceedings of the ICE – Water and Maritime Engineering, 142 (1):3 – 8.

[7] Drainage Services Department (2013): Stormwater Drainage Manual (with Eurocodes incorporated); Planning, Design and Management. Fourth Edition, May 2013. Government of the Hong Kong Special Administrative Region

[8] Enete, I. C., Ogbonna, C. E., Ayadiulo, R. U. (2012): Urbanization and the Challenges of Climate Change in Nigerian Cities; A Review. In Odjuo et al, Proceedings of the 2012 Annual Conference of the Nigerian Meteorological Society (NMetS). Department of geography and Regional Planning, Faculty of Social Sciences, University of Benin, Benin City, Nigeria. 150 – 155.

[9] Fatile, J. O. and Adejobi, O. S. (2012): Climate Change, Environment and Conflicts in Nigeria. British Journal of Arts and Social Sciences ISSN: 2046-9578, 6(1): 11 – 20,

[10] IPCC, (2007). Impacts, Adaptation and Vulnerability Summary for Policy Makers, Geneva, Switzerland. Retrieved on 24th April, 2014 from https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4_wg2_full_report.pdf

[11] Jimoh, H. I. (2008): Effects of River Erosion on Houses; A Case Study of Asa River Catchment in Ilorin, Kwara State Nigeria. Medwell Journals. The Social Sciences, 3 (2): 193 – 195

[12] Kumpulainen, S. (2006): Vulnerability concepts in hazard and risk assessment. Natural and Technological Hazards and Risks Affecting the Spatial Development of European Regions. Edited by Philipp Schmidt-Thomé. Geological Survey of Finland, Special Paper 42: 17 – 63.

[13] Matthews, T. (2011): Climate Change Adaptation in Urban Systems: Strategies for Planning Regimes. Urban Program, Griffith University, Brisbane, QLD 4111, Research Paper 32. SBN 978-1-921760-31-0

[14] Mulugeta, G., Ayonghe, S. S., Daby, O. P. Dube, Lucio, F. and Durrhiem, R. (2007): Natural and Human-Induced Hazards and Disasters in Sub-Saharan Africa. ICSU Regional Office for Africa SCIENCE PLAN approved by the ICSU Regional Committee for Africa, on 5–6 March 2007 in the Seychelles.

[15] OECD (2010), Cities and Climate Change. OECD Publishing. Retrieved on 20th September,

[16] 2014 http://dx.doi.org/10.1787/9789264091375-en. ISBN 978-92-64-06366-2 (print) ISBN 978-92-64-09137-5 (PDF).

[17] Ogbonna, A. C. and Allu, E. L. A. (2011): Climate Change and the Nigerian Built Environment: A Wake-up Call. In Ogusote et al (ed) Compilation of Seminar Papers of the Architect's Colloquium 2011, 417 – 431.

[18] Suleiman, Y. M., Matazu, M. B., Davids, A. A. and Mozie, M. C. (2014): The Application of Geospatial Techniques in Flood Risk and Vulnerability Mapping for Disaster Management at Lokoja, Kogi State, Nigeria. Journal of Environment and Earth Science, 4(5): 54 – 61

[19] Ogbo, A. I. and Onyedinma A. C. (2012): Climate Change Adaptation in Nigeria: Problems and Prospects. Sacha Journal of Environmental Studies, Volume 2 Number 1 (2012). Pp. 130-145. ISSN 2045-8479 (Print), ISSN 2045-8487 (Online).

[20] Ologunorisa, T. E. (2006): Flood Risk Assessment and Management in Nigeria. Perspective from the Niger Delta. Selfers Educational Books, Makurdi. ISBN: 978-070-612-7.

[21] Omole, F. K. and Akinbamijo, O. B. (2012): Land Development and Planning Laws in Nigeria: The Historical Account. Journal of Law, Policy and Globalization. ISSN 2224-3240 (Paper) ISSN 2224-3259 (Online). 8: 25 – 31

[22] Salami, A.W. and Sule, B.F. (2010): An overview on Reservoir operational Impact of Kainji, Jebba and Shiroro Dams on the Environment. Paper presented at the One-day seminar on Reservoir Operation, organized by Federal Ministry of Water Resources, Dams & Reservoir Operation department. Held at Vine Hotel, Durumi District, Abuja. 29th October, 2010. Retrieved on 13th October, 2013 from

http://www.thetidenewsonline.com/2010/11/01/lecture-seeks-flood-routing-on-rivers-niger-kaduna/

[23] Udofia, E. P. (2011): Applied statistics with multivariate methods. Immaculate Publications Limited. Enugu. ISBN: 978-036-231-2

[24] UNEP (2007): Cities and Urban Vulnerability in the context of Urban Environmental Management. Zero draft, for comments and discussion, 5 December 2007. Retrieved on 25th April, 2014 from http://www.preventionweb.net/files/5453_092UNE.pdf

[25] UNEP (2010): Review of Adaptation Best Practice in the Nile River Basin Region. Retrieved on 2nd October 2013 from www.unep.org

[26] UNESCAP (2000): Ministerial Declaration on Environment and Development in Asia and

[27] the Pacific, 2010 as adopted by the the sixth Ministerial Conference on Environment and Development in Asia and the Pacific on 2 October 2010. Retrieved on 2nd October, 2013 from http://www.unescap.org/MCED2000/pacific/background/vulnerability.htm

[28] UN-Habitat, (2010): Climate Change Strategy. Retrieved from www.unhabitat.org on 20th September, 2012.

[29] US Department of Transportation (2013): Urban Drainage Design Manual. Hydraulic Engineering Circular No. 22, Third Edition. Publication No FHWA-NHI-10-009

[30] Usman, B. A. and Tunde, A. M. (2011): Climate Change Challenges in Nigeria: Planning for Climate Resilient Cities. Department of Geography and Environmental Management, Faculty of Business and Social Sciences, University of Ilorin. Retrieved on 20th July,2015 from https://www.unilorin.edu.ng/publications/usmanba/4%20Climate%20Change%20Challenges.pdf

[31] van der Pol, J. (2012): Flood Proof Architecture: Concepts and Constructive Solutions to Adapt to Rising Water Levels. Retrieved on 12 August, 2016 from http://www.duravermeerbusinessdevelopment.nl

[32] Werner, P. and Zahner, R. (2009): Biological diversity in cities – a review and bibliography. Bundesamt fur Naturschutz BFN-Skrichten 245/2009. Born-Bad Godseberry Bondurant fur Natuschutz. Pp 57.

[33] Yamane, T. (1967): Elementary sampling theory. Engle cliffs, New Jersey: Prentice - Hall, Inc.

[34] Zakieldeen, S. A., (2008): Vulnerability of Khartoum City to Climate Change. University of Khartoum, Institute of Environmental Studies.

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.488[a]	.238	.231	2.15945	.238	32.548	1	104	.000
2	.549[b]	.302	.288	2.07787	.063	9.327	1	103	.003
3	.573[c]	.329	.309	2.04742	.027	4.086	1	102	.046

a. Predictors: (Constant), completely prohibit new building development on the river Niger flood plain

b. Predictors: (Constant), completely prohibit new building development on the river Niger flood plain, condition/ design of drains

c. Predictors: (Constant), completely prohibit new building development on the river Niger flood plain, condition/ design of drains, Distance of house from edge of Meme/Niger River

Table 1: Model Summary for the Hypothesis
Source: Researcher's Field Survey, May 2015

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